4 WATER RESOURCES IN TURKEY: AVAILABILITY, USE, AND MANAGEMENT

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Turkey is classified as a relatively water-abundant country with an average of 3,900 cubic meters per person per year availability of potential water resources. The potential cannot be fully developed, and the availability is not evenly distributed in time and space. Usable potential is 1,830 cubic meters per person per year, and 30 percent of this potential was consumed in 1993. The share of the agricultural sector in total consumption is around 75 percent. Lack of well-defined property rights and centralized supply management hinder the efficient use of already developed water resources.

4.1. INTRODUCTION

Development of water resources has been an important issue for Turkey because of the high rates of growth in population, in urbanization, and in industrialization. A more important factor for the use of water resources has been the need to expand irrigation development to support the income of the rural population and to achieve higher yields in crop production.

Some background information, giving more emphasis to the agricultural sector as a major consumptive user of water resources, is provided in the next section. Details of water resources availability and use in Turkey are discussed in the following section, along with a brief description of the much discussed Southeastern Anatolia Project (GAP). The legal and institutional aspects of water resource management and pricing in the water sector are then presented. The last section is reserved for concluding remarks.

4.2. BACKGROUND INFORMATION: SOME BASIC INDICATORS ON THE TURKISH ECONOMY

Turkey is considered to be a country relatively well-endowed in water resources. Per capita availability of potential water resources is 3,900

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cubic meters per year which is high for the Middle East. However, Turkey is also well-endowed in other resources, such as land and labor. The population (a resource that is problematic) is growing at an average rate of 2.2 percent per year, and it was a little over 60 million in 1994. About 60 percent of this population lives in the urban areas, and the remaining 40 percent is located in the rural areas. Urbanization rate is almost 5 percent per year since 1980. Active population accounts for 40 percent of the total population. In 1990 total active population was 22 million with about half of it (12 million) in the agricultural sector, 8 million in the services, and 3 million in the industrial sector. According to the official estimates, the unemployment rate is around 10 percent, but some estimates are as high as 18 percent.

Turkey has 28 million hectares of cultivated area, 20 million hectares of forests, and 15 million hectares of meadows. The limit of cultivable land has been reached with only 2 million hectares of land left for cultivation. A little more than 4 million hectares are irrigated. Field crops occupy 68 percent of the total cultivated area. Cereals dominate field crop production with 56 percent share in the field crop area. According to the 1991 General Census of Agriculture (SIS, 1992) 18 percent of the field crop area is irrigated. The irrigated farming is more widespread in perennial crops, especially in vegetables.

Combined with other factors of production, the GNP of Turkey recorded $174 billion, which corresponds to a per capita income of $2,853 in 1993. Between 1988 and 1993, the Turkish economy grew at an average rate of 4.4 percent per year. The shares of service and industrial sectors in the GNP were 61 percent and 25 percent, respectively. The share of agricultural sector was only 14 percent with half of the active population employed in the sector. In the 1960s, the agricultural sector produced one-third of the total output with 75 percent of the active population. This indicates a relatively slow rate of growth in agricultural labor productivity. Although the rate of growth in the agricultural sector shows wide fluctuations, the sector had a dismal performance, with a growth rate of 1 percent per year in the last six years. The crop yields in Turkey average only 0.9 tons of grain equivalent per hectare, mainly due to the semiarid climate (IAP-WASAD, 1993). The average growth rates of industrial and services sectors, in the same period, were 5.9 percent and 3.9 percent per year, respectively. The average increase in consumer price index was 65.6 percent per year from 1988 to 1993 (SIS, 1994).

Per capita consumption of electrical energy is quite low, with 900 kilowatts per person in 1992. The hydroelectric plants contributed 40 percent of the total electricity production (DSI, 1994).

The demand for water resources is certainly increasing at a high rate as a result of the high rate of urbanization and industrialization. More important is the demand of the agricultural sector. With irrigation and use of other modern inputs, the performance of the agricultural sector can be improved significantly. It is estimated that the yield per hectare may be as high as 5 tons of grain equivalent (IAP-WASAD, 1993). This situation puts pressure on the consumptive use of water resources. Pricing and efficient use of the potential water resources are two important issues that should be tackled in the near future. Recently, transferring irrigation schemes to users associations has gained momentum.

4.3. WATER AVAILABILITY AND USE IN TURKEY

4.3.1. The Overall Situation

Water resources in Turkey are not evenly distributed over time and space. The rivers flow irregularly and cannot be taken directly as usable resources. Annual precipitation, evaporation and surface runoff vary greatly. Annual average rainfall is 643 mm, which corresponds to 501,000 million cubic meters (mcm) of water per year. It is estimated that 274,000 mcm is lost through evaporation, 41,000 mcm feeds the underground reservoirs, and 186,000 mcm become river flow. External rivers contributes 6,900 mcm to the water potential (Kulga and Cakmak, 1994). Accounting all these resources, the gross renewable fresh water potential of Turkey adds up to 234,000 mcm. However, according to the surveys conducted by General Directorate of State Hydraulic Works (DSI), the technically and economically usable total water potential of Turkey is 110,000 mcm. The sources are from 95,000 mcm from surface runoff, 12,000 mcm from ground waters, and 3,000 mcm from external rivers.

For the year 1992, 25,900 mcm (27 percent of the usable potential) of the surface runoff, and 5,700 mcm of the ground water (48 percent of the potential) have been consumed (DSI, 1994). The corresponding per capita figures for utilizable water potential and water consumption are 1,830 cubic meters (cm) and 524 cm, respectively. Total consumption of water and sectoral decomposition are shown in Table 4.1. Sectoral distribution of water consumption shows the characteristics of a developing nation. The share of irrigation in total consumption is around

75 percent and is expected to remain almost constant until the year 2000. Furthermore, it might go up as high as 80 percent on the completion of the GAP project. Per capita domestic water consumption is less than 100 cm per year, which is quite low by European standards. According to Bilen and Uskay (1992), almost all of the population have access to drinking water, and significant progress in sewerage and sanitation systems have been achieved. Yet severe shortage of water is not an exception in all large cities. The investments of DSI and the municipalities were not able to keep up with the increase in the demand. This situation has a serious impact not only on the quantity but on the quality of water since the level of water in the reservoirs remains below the safe level. Water loss in urban water supply is unavoidable, but leakage loss in the water supply delivery network for some large metropolitan areas reaches as high as 65 percent of the total water supply. The water loss rate in Istanbul, which has one-fifth of the total population, was around 50 percent in 1992 (SIS, 1993).

Table 4.1. Water Consumption in Turkey

	Total Consumption	Develop-ment	Sectoral Consumption					
			Irrigation		Domestic		Industrial	
Year	million cubic meters (mcm)	%	mcm	%	mcm	%	mcm	%
1990	30,600	28	22,016	72	5,141	17	3,443	11
1992	31,600	29	22,939	73	5,195	16	3,446	11
1995	40,200	37	29,547	74	6,352	16	4,301	10
2000	46,500	42	34,875	75	6,882	15	4,743	10

Source: Kulga and Cakmak (1994).

Regional surface water potential is presented in Table 4.2. The irregularity in the spatial distribution of surface water potential is obvious from the table. The Eastern Anatolia Region has 30 percent of the potential but has 17 percent of the total population. More developed western regions are definitely short in water. For instance, the Marmara and Aegean regions have high population densities and relatively more irrigated land and yet only 13 percent of the surface water potential. Almost all of the available water is used in the Gediz and B. Menderes basins.

Hydroelectric potential of the river basins adds up to 122,000 GWh (DSI, 1994). The actual development of the hydroelectric potential is about 20 percent in 1993.

Table 4.2. Regional Distribution of Surface Water Potential of Turkey

Region/Basion Regions	Total (mcm/year)	Share (percent)	Per Person (cm/year)
Marmara and Agean	23,050	12.6	1,266
West Mediterranean	20,980	11.3	7,467
West Black Sea and Central	33,130	17.8	2,085
East Mediterranean	27,430	14.7	5,095
East Black Sea	25,830	13.9	6,077
East	55,330	29.7	5,704
Total	186,050	100.00	3,294

Source: DSI (1994).

4.3.2 Irrigation Development

Rain-fed agriculture covers 75 percent of the total arable land in Turkey. More than 5.0 million ha of arable lands are left for fallow. Water storage is indispensable for the irrigated agriculture, since the rivers carry base flow during the peak demand season of the crop pattern. Specific targets for the expansion of irrigation were always set in the five-year development plans to reduce the vulnerability of production to variation in rainfall. The target for the Sixth Five-Year Development Plan (1990 to 1994) was 53 percent of irrigable land, and it is almost achieved by 48 percent in 1993.

Irrigated land showed a steady increase of 4 percent per year since 1970 and reached 4.3 million hectares (Yavuz and Cakmak, 1995). At the end of 1994, institutional distribution of irrigation development was as shown in Table 4.3.

Table 4.3. Institutional Distribution of Irrigation Development

Institution	Net Irrigated Area (1,000 ha.)
State Hydraulic Works (DSI)	1,562
General Directorate of Rural Services (GDRS)	902
DSI and GDRS	270
Farmers	1,000
Gross irrigated area	4,270

The water basin studies indicate that 8.5 million hectares of land are "economically" irrigable, of which 48 percent are already irrigated. According to the experts the estimate of the irrigable land requires interbasin water transfer; hence, it should be considered as an optimistic estimate. Only 0.45 million hectares are irrigated from groundwater resources.

Surface irrigation methods (such as furrow, basin, border or flooding) are used in 95 percent of the total irrigated area. The remaining area is irrigated with sprinklers. Some microirrigation methods are used in the Aegean and Mediterranean regions. The average irrigation efficiency is around 41 percent, with a wide variation between 10 percent and 70 percent in 1990. "Considering the fact that almost the entire canal network (90 percent) is concrete lined, the low irrigation efficiencies are caused by the improper matching of supply and demands during the season, inaccurately executed water management programs, insufficient density of tertiary/quaternary canal system, poor field conditions (non-uniform slopes, poor leveling) and the reluctance of the farmers to irrigate at night" (IAP-WASAD, 1993).

Most of the future irrigation development will take place in the Euphrates and Tigris basins by the implementation of the ambitious regional development project of Turkey.

The Southeastern Anatolia Project (GAP) is an integrated multi-sectoral development project based on the development of water resources. The project region is the least developed region of Turkey. The purpose of the project is to narrow the gap in the standard of living between the region and the rest of Turkey. It incorporates not only irrigation development but the construction of all infrastructural facilities. The irrigation projects are planned to be completed by the year 2010, but because of the financial difficulties the full operation of the project might

be delayed. The full cost of project is estimated to be $32 billion. A separate administration has been established for project-related activities.

After the completion of the Project, 1.03 million ha and 550,000 ha of land will be irrigated in the Euphrates and Tigris basins, respectively (GAP, 1992). It is estimated that GAP will drain 9 mcm per year of water from Euphrates. This represents 30 percent of the average annual runoff of the river. It is estimated that a steady runoff equivalent 80 percent of the annual average flow will be provided to the downstream counties. The irrigation projects in the Tigris basin will consume 20 percent of the average annual runoff of the river.

It is often stated that the Project will enable Turkey to become a major exporter of agricultural products. A comparative static projection to the year 2010, taking into account domestic population and income growth and the potential developments in the world markets, indicates that agricultural exports of Turkey will increase from $2.13 billion in 1988, to $3.4 billion by the year 2010, if the project is fully operational (GAP, 1992).

4.4. INSTITUTIONAL STRUCTURE IN WATER RESOURCES

The institutional framework can be divided into two components: legislation that defines the property rights of the water resources and organizational structure in the management of water resources.

4.4.1. Water Rights and Ownership

All natural resources, except some privately owned small springs, are vested in the state in the Turkish Constitution. However, the property rights in water resources are not well defined in the legislation, especially for surface water.

The surface water is considered to be a public good, and everyone is entitled to use it subject to the rights of the prior users. According to this basic principle, authorization is not required to use the surface water. In the case of any disagreement among users, various local customary rules and regulations or as a last resort court decisions are used to settle the dispute. Special legislation on surface water requires prior authorization for the nonconsumptive use of water such as hydropower production, fishing, and thermal waters.

The use of ground waters is more clearly defined. According to the Ground Water Law, ground water is the sole property of the state, and DSI is the only legal authority responsible for investigation, use, and allocation of ground waters. Prior authorization is required to use all ground waters from DSI. The purpose of utilization and the extraction rate are cited on the permits issued by DSI. The permits are neither tradable nor transferable.

Although there has not been a legislation to define the water rights, special laws were enacted to determine the priorities in the use of all water resources among different sectors. The priorities are determined on a case-by-case basis. In general, the order of priorities is municipal uses, irrigation, and then hydroelectric power generation. The right to determine priorities gives DSI de facto control of all water resources.

There exist additional laws for the supply of drinking water, sewerage, and environment. DSI is responsible to provide water to the cities with more than 100,000 population subject to government authorization and city council approval. The provision of drinking water to the villages is under the responsibility of General Directorate of Rural Services (GDRS). The Bank of Provinces was established to assist all municipalities irrespective of size in financing and construction of their infrastructures including water supply and sewerage.

Environmental issues related to the water resources are legislated by the Law of Environment in 1983. Water pollution control regulation was enacted in 1988. It is a comprehensive piece of legislation that includes issues from wastewater discharges into water bodies to the restrictions on the use of pesticides and fertilizers in irrigated agriculture. Regulation on Environmental Impact Assessment was enacted in 1993.

4.4.2. Institutions in Water Resources Management

Several organizations have direct and indirect interest in water resources development and conservation. The prime ministry, state planning organization, and related ministries are at the decision-making level. Governmental organizations under the ministries are at the executive level. Governmental and nongovernmental organizations are at the water users level for execution, operation, and maintenance of the projects.

There are four major governmental institutions responsible for the development of water resources. DSI, under the Ministry of Public Works and Settlements, is the largest agency for the development of water resources for all purposes. DSI's duties are to plan, design, and construct works for irrigation, drainage, flood protection, water supply, and

treatment. All phases of hydroelectric schemes, from planning to construction, are also among the duties of DSI. After the completion, it hands over the hydroelectric plants to Turkish Electricity Authority for generation and distribution of electricity. In addition, water- and soil-related investigations, preparation of river basin development plans, formulations of proposals for construction, financing, and, in most of the cases, subsequent operation of the works completed fall under the responsibility of DSI.

DSI has a three-tiered line organization. The top management and staff levels are located in Ankara. At the execution level, Turkey is divided into twenty five regional directorates. The regional directorates are further divided into field district offices. DSI had about 27,000 employees in 1993.

GDRS, under the Ministry of State, has the following water-related responsibilities: to complete on-farm canals of the DSI irrigation schemes, to develop the water resources up to 500 liters per second for irrigation purposes and field leveling, and to supply drinking water to the villages.

General Directorate of the Bank of Provinces is responsible for the development of municipal infrastructural projects. Construction and/or financing of drinking water and sewerage projects falls under this institution.

General Directorate of Electrical Power Resources Survey has the responsibility for conducting hydrological studies and geotechnical investigations, and for preparing a master plan and final design of the projects.

Users organizations are formed for the operation and maintenance of the irrigation schemes in accordance of the transfer policy of DSI. There are five different types: irrigation group, irrigation cooperative, village legal entity, municipality, and water user association. Any one of these types may be used by farmers depending on the size of the irrigation schemes and the preference of the farmers. Irrigation cooperatives are formed mainly for operation and maintenance of ground water irrigation. Water user associations are the most appropriate organization for large-scale irrigation schemes, and its statute has to be approved by the cabinet.

4.5. PRICING IN THE WATER SECTOR

Pricing and cost-recovery policies vary among sectors. There is almost no volumetric system in irrigation, whereas volumetric charges are common in domestic and industrial use. The farmers are not charged any fees

based on the resource value of the water they use for irrigation. They pay an annual area-based fee for DSI-operated irrigation schemes. It has two components. The first component, which is the significant portion of the fee, is intended to recover the costs of operation and maintenance (O&M) expenses incurred by DSI in the previous year without any inflation adjustment. This fee varies by crop grown and by region. Furthermore, the government has the right to adjust the fees, and they are usually set lower than the rate proposed by DSI. For instance, in 1993, the O&M fees per hectare of wheat were $12 for gravity irrigation and $33 for pump irrigation; same fees for cotton were $34 and $80, respectively (DSI, 1994).

The second component of the water charge is intended to recover the capital cost of a project. First of all, DSI is not allowed to charge any capital recovery cost for ten years after the project completion. Furthermore, the project's net present value at the completion date is amortized over a period not exceeding fifty years. Again no inflation adjustment is allowed. The charges vary by region, and they ranged from $0.3 to $0.7 per hectare in 1993 (DSI, 1994).

Despite these favorable terms in the determination of the fees, there exists a huge gap between the assessments and collection of water charges due to negligible penalties for late payments. The collection rate in the irrigation development operated by DSI (75 percent of total area developed by DSI) was never more than 50 percent since 1985 and 33 percent of the fees was collected in 1992 (DSI, 1994).

The financial burden of DSI increased with the expansion of the irrigated area. Fortunately, the growing experience of the farmers in irrigation increased their willingness to participate to operation and maintenance activities. In 1993, with the World Bank's persuasion and encouragement, DSI accelerated the transfer of irrigation schemes. By the end of 1994, 0.3 million hectares of net irrigated area were transferred to users. The transferred area reached 0.7 million hectares in June 1995, and planned to reach 1 million hectares by the end of 1995 (Yavuz and Cakmak, 1995). No special legal action was necessary for the transfer program.

GDRS transfers all groundwater projects, and since 1992 all small-scale surface water projects to irrigation cooperatives free of charge. The irrigation cooperatives are responsible for the O&M costs and payback the capital cost of pumps (if the pump is provided by DSI) on very advantageous terms again.

Water charges for domestic and industrial use in the urban areas are determined by the municipal assemblies. The charges account for 100

percent of the operation, maintenance, and amortization of capital costs over thirty years. Large cities incorporates the sewage disposal costs in the price of water. Volumetric charging system is also common in the rural areas for domestic water consumption. Average price for Istanbul was $2.8 per cubic meter in 1993.

4.6. CONCLUDING REMARKS

Turkey can be divided roughly into two regions with respect to per capita potential water availability: a relatively water poor Western Region formed by the Marmara and Aegean regions of Turkey, and the rest of Turkey as the relatively water rich region. The Western region is densely populated, relatively more industrialized, and heavily involved in cash crop production. Interbasin transfers and, especially in the Western Region, intersectoral transfer of water are indispensable. Yet intersectoral transfer is legally impossible since water use rights are not clearly defined. They are acquired by putting water to "beneficial" use (Bilen and Uskay, 1991). Trade cannot take place. There is a need to review existing legislation or to enact a water law to clarify the users' rights.

Management of water resources in Turkey shows typical characteristics of a centralized supply management scheme. One huge organization is responsible from almost all phases of hydrodevelopment. The main organizational structure of DSI has not changed since the early development years of water resources in 1950s. It is responsible from the construction of Ataturk Dam, on the one hand, and from preparing maps for irrigation areas on the other. It also maintains an operation and maintenance function as well as research and development. The creation of more specialized institutions for some duties of DSI, with effective coordination, will definitely provide more flexibility and better use of available human resources. The coordination among government institutions is a crucial issue. For instance, GDRS is responsible from finishing on-farm works for the irrigation schemes developed by DSI, but the lack of synchronization between the investment programs of these two institutions prohibits the delivery of water to the fields in some projects.

Engineering and construction culture dominates in all water-related institutions as a result of supply management orientation (Yavuz and Cakmak, 1995). Users participation in the decision-making process will improve the effectiveness of the projects and will certainly increase the water use efficiency when the project is completed. Transfer of irrigation schemes to the users for operation and maintenance is a positive step

toward achieving user participation in the initial phases of water resource development.

By the year 2010, per capita water availability in Turkey will be slightly less than 2,500 cubic meters per year. Generally, countries with annual water availability between 1,000 and 3,000 cm have major problems during drought years. Conflicts in sectoral allocation of water will certainly arise. The burden of adjustment will ultimately fall on the agricultural sector as the major consumptive user. Increase in water use efficiency of already existing irrigation systems will not only save water, but it will also improve the yields.

The environmental problems related to water resources have reached quite dangerous levels in Turkey and should be analyzed elsewhere. However, a couple of statistics to pinpoint the importance of the issues are in order: 72 percent of the cultivated area is affected by water-borne erosion; 1.5 million hectares of soil contains concentration of sodium or other salts high enough to have significant impact on yields. The levels of dissolved oxygen were almost down to zero in Sakarya and Yesilirmak rivers in the recent past. The effectiveness of the laws and regulations, which depend on the monitoring and enforcement abilities of the government, is yet to be seen.

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